Project Title: Molting ecology of Surf and White-winged Scoters in Southeast Alaska (SDJV Project # 107).

Date: 29 September, 2010
FY2010 – Year 3 of a 3 year study

Principal Investigators:
Jerry Hupp, U.S. Geological Survey, Alaska Science Center, 1011 East Tudor Road, Anchorage, AK, 99503; jhupp@usgs.gov; (907) 786-3303

Dan Esler, Centre for Wildlife Ecology, Simon Fraser University, 5421 Robertson Road, Delta, BC, V4K 3N2; desler@sfu.ca; (604) 940-4652

Rian Dickson, Centre for Wildlife Ecology, Simon Fraser University, 8888 University Drive, Burnaby, BC V5A 1S6; rdd@sfu.ca; (778) 782-5618

Brian Uher-Koch, Centre for Wildlife Ecology, Simon Fraser University, 8888 University Drive, Burnaby, BC, V5A 1S6; buherkoc@sfu.ca, (778) 782-5618

Partners:
Joseph R. Evenson, Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia, WA 98501-109, Joseph.Evenson@dfw.wa.gov

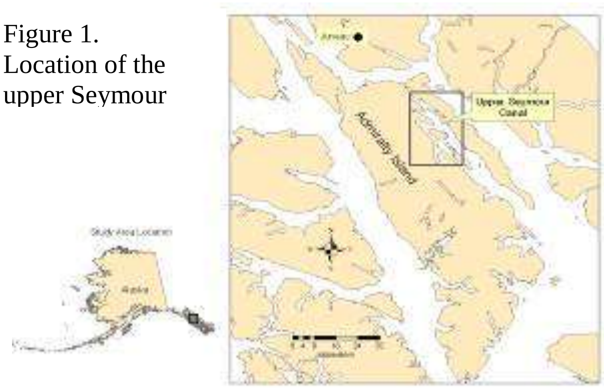
U.S. Fish and Wildlife Service, 3000 Vintage Blvd., Suite 201, Juneau, AK 99801

U.S. Forest Service, Admiralty Island National Monument, Tongass National Forest, 8501 Mendenhall Loop Road, Juneau, AK, 99801

Project Description:
Although Surf and White-winged Scoters (*Melanitta perspicillata* and *M. fusca*) are being studied at most parts of their annual cycle, the period of wing molt has not been addressed on the Pacific coast. Surveys have shown that at least 185,000 scoters, a sizeable proportion of the Pacific populations of these species, undergo wing molt in SE Alaska (Hodges et al. 2008). To provide a comprehensive evaluation of the ecology of these sea ducks, and to consider potential constraints on population dynamics, we have conducted research to quantify several aspects of molt ecology. This will provide data to evaluate population dynamics and identify important habitats of these declining species - high priorities in the SDJV Strategic Plan.

We conducted field work for this study during late summer 2008 and 2009 in upper Seymour Canal on Admiralty Island (Figure 1), an area of Southeast Alaska that holds significant numbers of molting scoters, and is representative of molting habitats of scoters in the region. We conducted surveys of scoter abundance, distribution, and species and sex composition from late July through September.

Figure 1. Location of the upper Seymour



We captured molting scoters using gill nets. All scoters were identified to species, sex was determined based on plumage and cloacal characteristics, and age class was estimated based on bursal depth and plumage attributes. Morphometric features (diagonal tarsus, culmen, and bill width) were measured as well as wing attributes (wing chord, wing stub length, and ninth primary length) to determine stage of wing molt. Feather wear of individuals with fully grown wings was used to determine whether the primaries have been molted recently. Finally, we measured body mass (± 1g) to assess variation in mass relative to stage of molt, species, age, and sex. Feather and blood samples were collected from a subset of the captured scoters, for stable isotope, plasma metabolite, and contaminant analysis. All data are referenced to a uniquely-numbered USGS metal tarsus band that was attached to each captured scoter. Captures were conducted at approximately 2-week intervals throughout the field seasons to evaluate relationships among molt stage, molt initiation date, and variation in body mass.

We attached radio transmitters to a subset of individuals (n = 50 in each year, distributed roughly evenly among species, age, and sex cohorts) to quantify survival, foraging effort, and movements. Foraging effort, defined as the proportion of time under water, has proven to be a good indicator of overall foraging conditions for scoters (Kirk et al. 2007, Lewis et al. 2008). We measured foraging effort by monitoring radioed individuals for one hour observation periods. Diving was indicated by the disappearance of the radio signal, and observers recorded the times of signal loss and return to generate estimates of time under water. We spread monitoring efforts across individuals, time of day (including nocturnal observations), tide stage, and stage of molt.

There are a number of general issues associated with avian molt ecology that our research addresses. For example, the trade-off between habitat safety (survival), food availability (foraging effort), and nutrient reserve use (mass changes) will be considered using our data. Along with theoretical interest in these topics, this information will be extremely valuable for understanding whether the period of wing molt could pose a demographic constraint. For example, survival during wing molt can be contrasted with survival estimated at other periods of the annual cycle (D. Esler, unpubl. data). This demographic perspective will lead to direct implications for management, by indicating whether the period of wing molt could act as a population bottleneck.

Objectives:
Our research addresses the following questions:

1) What is the timing of wing molt and does it vary by species, sex, age, or year?
2) What is the species, sex, and age composition of flocks of molting scoters?
3) How does body mass vary over the wing molt process, after accounting for effects of species, sex, age, date, and year?
4) What is the foraging intensity of scoters during wing molt, relative to during winter? Do they forage nocturnally?
5) What are survival rates during wing molt and do they vary annually?
6) How far do individuals move during wing molt, what habitats do they use, and is there annual variation in movements or habitat use?
7) What proportion of birds marked in the first year of study are recaptured in the second year, and how far from original capture sites are recapture locations?

Preliminary Results:
The planned two years of field work for this project have been completed (2008 and 2009). For more specific information on those two field seasons please refer to past progress reports submitted to the SDJV. Over the two field seasons, 715 molting scoters were captured and transmitters were deployed on 105 individuals (Table 1). A concurrent study of scoter molt ecology was conducted in Puget Sound-Georgia Basin (PSGB), and for many analyses both data sets will be used. The two study sites are separated by about ten degrees of latitude, and differ widely in habitat types and human disturbance levels. Analyzing these data sets together will allow us to draw much broader conclusions about remigial molt in scoters than would be possible from a single study site.

Table 1. Molting scoters captured and marked with VHF radio transmitters in Seymour Canal, Alaska (SEAK) and Puget Sound-Georgia Basin (PSGB), 2008 and 2009 combined.

	Study site	**SUSC female**	**SUSC male**	**WWSC female**	**WWSC male**	**Total**
# captured	SEAK	136	383	37	159	**715**
	PSGB[a]	1485	741	106	548	**2880**
# VHF	SEAK	36	30	13	26	**105**
	PSGB	24	20	7	12	**63**

Note: [a]In addition,17 scoters that had originally been captured during molt in 2008 were recaptured in 2009.

Wing Molt Chronology: Wing molt initiation dates were back-calculated for each individual scoter from the length of the right 9th primary feather at time of capture. Estimates of feather growth rates were based on captive scoters and within-year recaptures of molting scoters in PSGB. With molt initiation date as the response variable, a candidate model set was created with site (SE Alaska and PSGB), year, and cohort (sex/age class) as the explanatory variables. Models were run separately for the two species. The candidate model sets included all additive combinations of the explanatory variables and all two-way interactions. Generalized linear models with an information-theoretic approach were used to evaluate these candidate models, and the top supported models indicate that all the explanatory variables tested affect wing molt initiation dates. The AIC weights for the top supported models and the null models are shown (Table 2).

Table 2. General linear model results assessing variation in wing molt initiation dates for Surf Scoters and White-winged Scoters molting in SE Alaska and Puget Sound-Georgia Basin; the top two best-supported models and the null model are shown.

Model	**No. Parameters**	**ΔAIC_c**	**AIC_w**
Surf Scoter			
Site + Cohort + Year + SitexCohort + SitexYear + CohortxYear	14	0.00	0.98
Site + Cohort + Year + SitexYear + CohortxYear	11	8.36	0.02
Null	2	2569.77	0.00
White-Winged Scoter			
Site + Cohort + Year + SitexYear + CohortxYear	11	0.00	0.46
Site + Cohort + Year + CohortxYear	10	0.30	0.40
Null	2	417.08	0.00

Note: [a]Cohort is a combination of sex and age class (second year or after second year)

For Surf Scoters, the best supported model received a very high degree of support and for White-winged Scoters, the top two models (which were quite similar) received high levels of support. For both species, this analysis indicates that molt initiation date varies by site, cohort and year. For Surf Scoters, all two-way interactions between those variables were also included in the top-supported model, and for White-winged Scoters the interaction between Cohort and Year was included in both of the top-supported models. In addition, the R^2 values for these models are relatively high (0.6 and 0.4 for the top-supported models for SUSC and WWSC, respectively).

In general, there were wide ranges of wing molt initiation dates in almost all cohorts (excepting adult White-winged Scoter females in SE Alaska, where n=3) (Figures 2 and 3). Mean initiation dates for most cohorts were earlier in SE Alaska than in PSGB. Mean initiation date of wing molt was 20-35 days later for adult female Surf Scoters as compared to adult males or subadults, at both study sites. Interestingly, in the subadult cohorts, males initiated wing molt earlier than females, although it is likely that subadults of both sexes remain on the coast and do not migrate to the breeding grounds.

Figure 2. Date of initiation of wing molt in Surf Scoters in Southeast Alaska and Puget Sound-Georgia Basin (SY= second year, ASY=after second year). Green lines indicate mean initiation date for each cohort; ordinal date is on the x-axis (i.e. January 1 = 1).

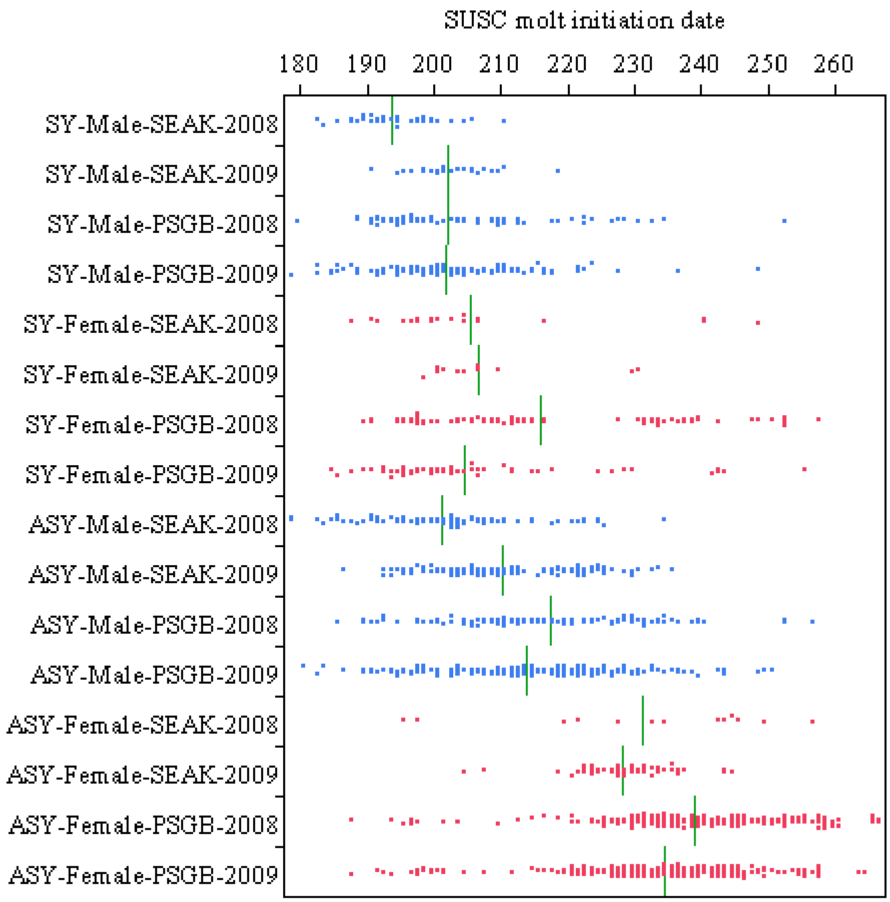
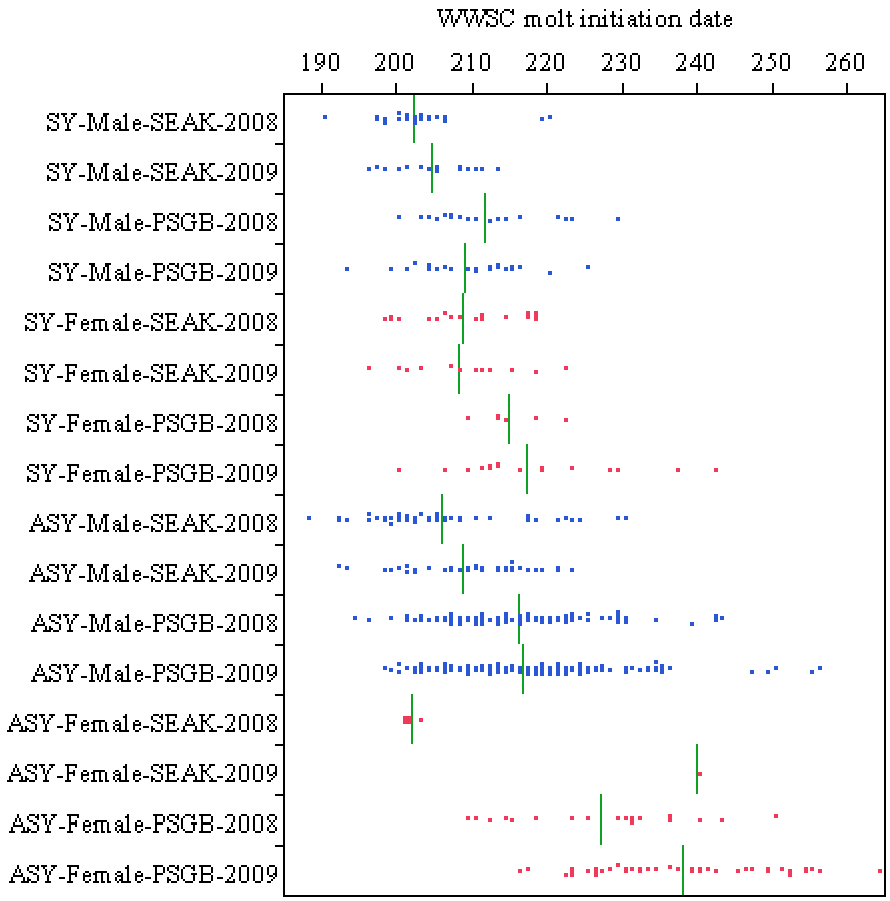


Figure 3. Date of initiation of wing molt in White-winged Scoters in Southeast Alaska and Puget Sound-Georgia Basin (SY= second year, ASY=after second year). Green lines indicate mean initiation date for each cohort; ordinal date is on the x=axis (i.e. January 1 = 1).



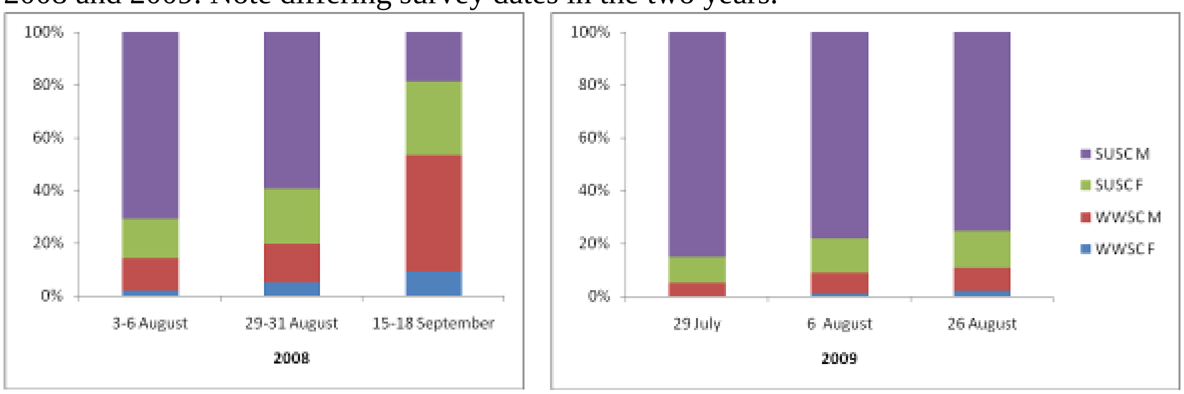
Abundance and composition of molting flocks: In both years, the highest numbers of scoters using the study area in northern Seymour Canal on Admiralty Island were observed in early August, with about 16,000 scoters counted in the area (Table 3). In 2009, we were able to survey the area about one week early and there were less than half that number of scoters present, indicating that many arrived at the end of July or beginning of August. Also, in both years the number of scoters in the area decreased in August, with only 8000 scoters left in the area by early September. Given the shift in the species and sex composition of the molting flocks (see below), it appears that some individuals are arriving during this period, as others leave, so it is likely that the total number of scoters that uses this area in a given summer is higher than our maximum counts.

Table 3. Total numbers of scoters counted in the Seymour Canal study area during 2008 and 2009. Due to additional crew and more favorable weather conditions in 2009, more surveys were completed.

2008		**4 August**	**30-31 August**	
		16 000	10 500	
2009	**28 July**	**6 August**	**26 August**	**7 September**
	7400	16500	12 800	8000

The flocks of molting scoters were comprised predominantly of male Surf Scoters in both years (Figure 4). In 2009, we were able to complete species/sex surveys as early as 29 July, and found that 85% of the scoters in the area were male Surf Scoters. In 2008, the first survey, completed between 3-6 August, found just over 70% male Surf Scoters. In both years, the proportion of White-winged Scoters and the proportion of females of both sexes increased throughout the season. This is probably due both to male Surf Scoters leaving the area as they complete remigial molt and the later arrival of White-winged Scoters and adult females. However, the proportion of female White-winged Scoters remained low, reaching just 9% by mid-September 2008 and only 2% in late August of 2009. This was also reflected in our captures, with only 5% of the captured scoters being female White-winged Scoters.

Figure 4. Species and sex composition of flocks of molting scoters in Seymour Canal, Alaska in 2008 and 2009. Note differing survey dates in the two years.



Body mass variation: In preliminary data exploration, no strong relationships between body mass and 9th primary growth were found in molting scoters in SE Alaska and PSGB (Figure 5). Moreover, body mass during wing molt is as high, if not higher, as it is during other phases of the annual cycle (Figure 6) (S. Slattery, D. Esler and C. VanStratt, unpublished data). This data set will be analyzed using general linear models in an information-theoretic framework to determine whether mass varies in relation to 9th primary length, age, site, year, or moult initiation date.

Figure 5. Body mass of molting scoters SE Alaska and PSGB in relation to length of 9th primary during remigial moult. Shaded regions indicate 95% confidence limits.

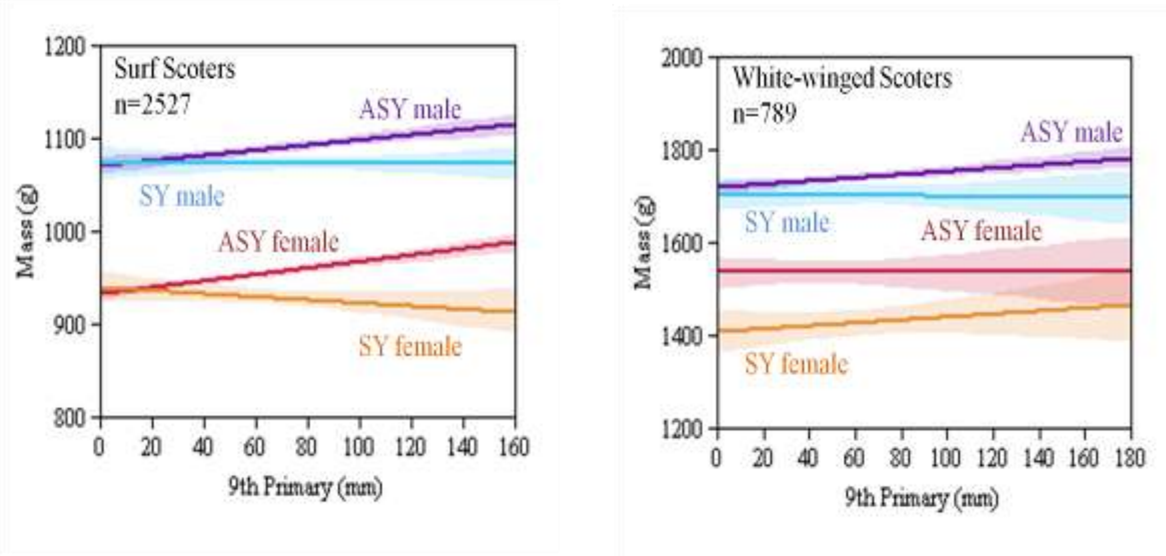
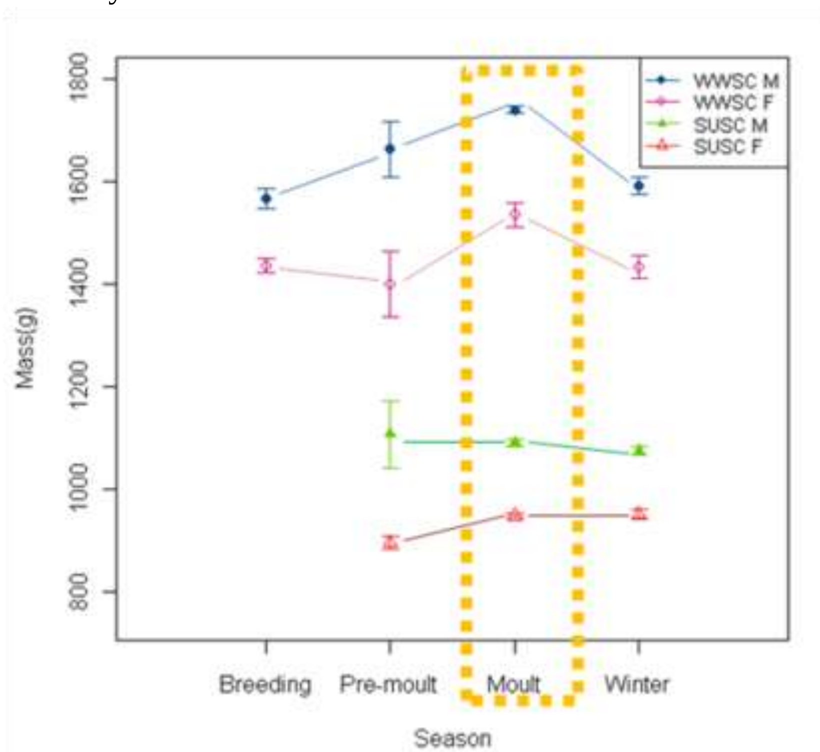


Figure 6. Body mass of adult Surf Scoters and White-winged Scoters at various stages of the annual cycle.



Foraging effort: Hourly foraging effort is defined as minutes spent underwater per hour and daily foraging effort can be extrapolated from those values, based on the amount of time between sunrise and sunset. Preliminary summaries of these data indicate that during wing molt females of both species seem to be spending more time foraging than do males. This is differs from studies of Surf and White-winged Scoter foraging behavior in British Columbia during the winter, which found little evidence for differing foraging rates between sexes (Kirk *et al.* 2007 and Lewis *et al.* 2008). Hourly foraging rates for Surf Scoters in SE Alaska were very similar during wing molt and winter (C. VanStratt, unpubl. data), and are slightly lower than the rates observed in British Columbia during winter. However, for female White-winged Scoters, foraging rates appear to be higher during molt than during winter. Further analysis of this data will take into account stage of feather re-growth, environmental variables (tide, weather, and wind conditions), and decreasing day length during the wing molt period.

Survival: Data from radio-marked birds tracked during this study will be used in detailed survival analyses to be completed by Brian Uher-Koch. Generally, overall mortality seemed quite low during the wing molt phase in SE Alaska. Of the 105 radios deployed, only 5 were detected as mortalities. All of these confirmed mortalities were Surf Scoters. From the recovered carcasses/radios, it was difficult to determine if these scoters had been actually killed by a predator or were scavenged after dying of other causes. Two of the carcasses appeared to have been eaten by bald eagles and three by mustelids (mink or river otter). It is likely that at least one of these latter individuals was actually killed, as red blood spots were found on some feathers.

Movements: We collected general location data for radio-marked molting scoters, which will be analyzed in more detail in the future. However, we found that individuals tended to use the same bays (scales of hundreds of meters to single-digit kilometers) through the entirety of the remigial molt period and often stayed in the same area for a period of time after completing molt.

Recaptures: At the study site in Southeast Alaska, there were no between-year recaptures of molting scoters. This was probably because we captured a small proportion of the large numbers of scoters that used the area, rather than other factors such as low site fidelity or annual survival. We caught approximately 300 and 400 scoters in 2008 and 2009, respectively. In both years there were >16,000 scoters present at the peak of the molt season, and probably more than that number use the site over the course of the capture period. With these numbers, the chances of recapturing individuals from one year to the next are quite low (in both years we had just one within-year recapture). In Puget Sound-Georgia Basin, there were 17 between-year recaptures (individuals originally caught during molt in 2008, and then caught again in 2009) and over the two years there were 40 within-year recaptures.

Project Status

All field work for this project has been successfully completed. Data have been summarized, and some analyses (variation in molt initiation date) are finished. Data analyses will continue in the coming year. Rian Dickson is expected to wrap up her M.Sc. thesis in early 2011, and will produce several manuscripts for publication based on this work. Brian Uher-Koch is beginning his M.Sc. work and will be focusing on survival analyses, using data from this study and other studies of scoter during non-breeding phases of the annual cycle.

As the first evaluation of molting ecology of scoters in Pacific North America, this work investigates potential constraints faced by scoters at this stage of the annual cycle. These data do not indicate that there were any energetic or demographic constraints on either species during wing molt. Therefore, as long as habitat quality is maintained, it is likely that the wing molt period is not a bottleneck in the annual cycle of these species, i.e., observed numerical declines are not related to constraints manifested during remigial molt. It appears that scoters aggregate in larger and denser flocks than are usually observed during winter. This suggests that the areas used during remigial molt are important coastal habitat for scoters.

One challenge to meeting the objectives of this study was the low numbers of female White-winged Scoters (particularly adults) in both study areas. While we have greatly increased our knowledge of the ecology of molting scoters on the Pacific coast of North America, we still know relatively little about this annual cycle phase for adult female White-winged Scoters specifically.

Acknowledgements
We would like to thank Allison Patterson, Vanessa Richard, Jon Brown, John Whissel, Anthony Pagano, Paul Levesque, Tim Bowman, Robbie Piehl, Gwen Baluss, Lucie Parker, Rob MacDonald, and John Reed for all their hard work and good humour in the field on Admiralty Island. Eric Anderson, Corey VanStratt, Brian Uher-Koch, Danica Hogan, Eric Palm, and Jennifer Barrett of the Centre for Wildlife Ecology have provided support and advice throughout this project. And we greatly appreciate the generosity of the Mattson family in Juneau, for allowing us to use their cabin in King Salmon Bay – we would have been much damper and grumpier without it!

Literature cited:

Hodges, J. I., D. J. Groves, and B. Conant. 2008. Distribution and abundance of waterbirds near shore in Southeast Alaska. Northwestern Naturalist 89:85-96.

Kirk, M., D. Esler, and W. S. Boyd. 2007. Foraging effort of Surf Scoters (*Melanitta perspicillata*) wintering in a spatially and temporally variable prey landscape. Canadian Journal of Zoology 85:1207-1215.

Lewis, T. L., D. Esler, and W. S. Boyd. 2008. Foraging behaviours of Surf Scoters (*Melanitta perspicillata*) and White-winged Scoters (*M. fusca*) in relation to clam density: inferring food availability and habitat quality. Auk 125:149-157.